

REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-01-

0096

sources,
of this
Jefferson

Public reporting burden for this collection of information is estimated to average 1 hour per response, in gathering and maintaining the data needed, and completing and reviewing the collection of information. Collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, F Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, F

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. RE	Final - 01 September 1997 - 31 August 2000
4. TITLE AND SUBTITLE AASERT 97 - Auditory Processing During Head Movements			5. FUNDING NUMBERS F49620-97-1-0363
6. AUTHOR(S) Dr. William A. Yost Parlmy Hearing Institute			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Loyola University Chicago 6525 N. Sheridan Road Chicago, IL 60626			8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NL 801 North Randolph Street, Room 732 Arlington, VA 22203-1977			10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION AVAILABILITY STATEMENT APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED			AIR FORCE OFFICE OF SCIENTIFIC RESEARCH NOTICE OF TRANSMITTAL DTIC THIS TECH. HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE LAWAFR 100-12. DISTRIBUTION IS UNLIMITED.
13. ABSTRACT (Maximum 200 words) The first experiments to measure head movements while subjects are localizing sounds they can hear and see and sounds they can only hear have been completed, and the results of these experiments were presented at the June meeting of the Acoustical Society of America (Yost and Mapes-Riordan, 1997). We have developed a new methodology for investigating precedence-like effects (Stellmack, Dye, and Guzman, 1998). We studied the role of masking in the precedence effect (Guzman and Yost, in press). We also have collaborated on a major review of the precedence effect (Litovsky et al. in press) in which attempt to establish a nomenclature and organizing theory for the many effects that are collectively referred as the precedence effect.			
14. SUBJECT TERMS			15. NUMBER OF PAGES 7
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT

20010220 062

**Auditory Processing During Head Movements
Final Progress Report for 1997-00**

Technical

NL

AFOSR-F49620-97-0363-P00001
ASSERT-97

Principal Investigator: William A. Yost

Parmly Hearing Institute
Loyola University Chicago
6525 N. Sheridan Rd.
Chicago, IL 60626

773-508-2710
Fax: 773-508-2719
wyost@luc.edu
<http://www.parmly.luc.edu/>

Auditory Processing During Head Movements

Objectives: The primary objective of the grant is to better understand the role of head movement in processing sounds, especially in reverberant environments.

Status of Effort: The first experiments to measure head movements while subjects are localizing sounds they can hear and see and sounds they can only hear have been completed, and the results of these experiments were presented at the June meeting of the Acoustical Society of America (Yost and Mapes-Riordan, 1997). We have developed a new methodology for investigating precedence-like effects (Stellmack, Dye, and Guzman, 1998). We studied the role of masking in the precedence effect (Guzman and Yost, in press). We also have collaborated on a major review of the precedence effect (Litovsky et al, in press) in which attempt to establish a nomenclature and organizing theory for the many effects that are collectively referred as the precedence effect.

New Findings:

How do listeners weigh the information from the source and reflections in a precedence-like task?

Relative weights given to interaural differences of time (IDTs) of source and echo clicks were computed for a range of echo delays (1-256 ms) for stimuli presented over headphones. On each trial, source and echo IDTs were selected randomly and independently ($\mu=0$ and $\delta=100 \mu\text{s}$). Listeners were instructed to indicate the direction of the IDT, left or right, of the source or the echo (in separate conditions). Weights were obtained by computing the correlation between the source or echo IDT and the listener's binary responses. In all conditions, little weight was given to the echo at short echo delays (<8 ms), but the echo was given weight equal to or greater than that of the source at intermediate echo delays (8-32 ms). For echo delays >32 ms, listeners gave greater weight to the source or echo, as appropriate. For all echo delays, when listeners were instructed to indicate the direction of the source IDT, the percent correct was lower when the echo DT varied across trials than when it was fixed at 0 us, indicating that the binaural information of the echo was not completely suppressed in any condition.

Masking and the Precedence Effect:

The present experiments investigate the influence of forward masking in precedence effect phenomena. A forward masking and a fusion threshold adaptive tracking paradigm were employed to obtain masked and fusion thresholds (respectively) in the presence of multiple click events (source plus echo clicks) in the free field under conditions of a reversal switch (in which the source click and echo click switch locations) and a lateral switch (in which the source click and echo click move one loudspeaker to the left). In the masking conditions, listeners detected the echo click in the presence of the source click. In the fusion conditions, listeners indicated whether they heard one or more than one distinct click. The relative level of the echo changed based on listener's response following a 1-up 2-down rule. Two tracks with randomly interleaving sequences were used. Results show that although the absolute values obtained are lower for masked than for fusion thresholds, the threshold patterns as a function of number of click events are similar in the two conditions tested.

A review of the Effects of Precedence:

This work provides a review of recent psychoacoustical and physiological work (since the mid 1980's) on the effects of precedence. The "Precedence Effect" refers to a set of phenomena that exist when listening in reverberant environments. The basic finding has been that auditory perception is dominated by the first acoustic information to arrive at a listener, as if the information from the source takes precedence over that of later arriving echoes. That is, when a lagging (echo) sound is perceptually fused with that of a leading (source) sound, the perceived spatial location of the fused sound is dominated by the location of the lead, and the ability to make discriminations based on the lag is suppressed relative to the discriminations that can be made for the lead. Most of the recent findings and those of early experimenters can be categorized into measurements of fusion, localization dominance, discrimination suppression, build-up of precedence, and breakdown of precedence. When a lead-lag sound that is designed to simulate a source and its echo are repeated, many of the effects of precedence become stronger. Certain changes to the stimulus characteristics of a repeated lead-lag stimulus pair can result in a release of many of the effects of precedence. These measurements have been made both in the free-field and under a variety of headphone listening conditions. These effects of precedence have been measured in many animal models and across the life span for several animals. There is an emerging set of physiological measurements that are relevant to providing a fuller understanding of the effects of precedence. While no fully developed theory or model of precedence has been proposed, different attempts of providing models of precedence are reviewed.

Iterated Rippled Noise:

We have conducted several studies involving iterated rippled noise (IRN). IRN stimuli are generated when a source sound is added to multiple, exact copies (echoes) of the original sound. IRN sounds have a pitch/timbre that is related to the echo delay and the strength of this pitch/timbre is related to the number of echo copies and the amount of attenuation the copies undergo before they are added back to the original noise source. We have shown that the pitch/timbre of IRN stimuli and the strength of the pitch/timbre is not related to the spectral content of the IRN stimuli, but rather to the temporal regularity in the sound's fine structure. This temporal regularity can be revealed by constructing the autocorrelation function of the stimuli. We have shown that a computation model of auditory processing which produces a correlogram (an autocorrelation-like process) can also account for almost all of the data generated to date. Our current work has shown that the envelope of a sound consisting of a direct sound and a reflection cannot be the primary basis for determining the distinct pitch/timbre of the sound. This pitch/timbre is determined primarily by the stimulus' fine structure.

Personnel Supported: Sandy Guzman, PhD, granted in 1999, Dan Mapes-Riordan, PhD student, William Whitmer, PhD candidate

Publications:

Directly Related to the Grant:

1997

Sheft, Stanley and Yost, William A, Binaural modulation detection interference, Journal of the Acoustical Society of America, 102, 1791-1798, 1997

Yost, William A. The Cocktail Party Effect: 40 Years Later, in Localization (R. Gilkey and T. Anderson, eds) Erlbaum Press, New Jersey, 1997

Yost, William A., and Dye, Raymond, Binaural Psychophysics, Seminars in Hearing: Binaural Issues in Clinical and Rehabilitative Audiology, Thieme Medical Publishers, Inc., 1997

Yost, William A. Dan Mapes-Riordan, and Guzman, Sandra J. Relationship between Localization and the Franssen Effect, Journal of the Acoustical Society of America 101, 2994-2997, 1997

1998

Stellmack, M. A., Dye, R. H. Jr., and Guzman, S. J. (1998). "Observer Weighting of Interaural Delays in Source and Echo Clicks," Journal of the Acoustical Society of America, 105, 377-387.

Yost, William A. Book Review: Spatial Hearing: The Psychophysics of Human Sound Localization (3rd Edition; by J. Blauert), Ear and Hearing, 167-168, 1998

1999

Litovsky, R., Colburn, S., Yost, W.A., and Guzman, S. (1999) The Precedence Effect: A Review, Journal of the Acoustical Society of America 106, 1633-1654.

Guzman, S., and Yost, W.A. Masking and the Precedence Effect, Journal of the Acoustical Society of America, in press

Mapes-Riordan, D. and Yost, W.A. (1999) Loudness recalibration as a function of level, Journal of the Acoustical Society of America, 106, 3506-3511

Indirectly Related to the Grant:

1997

Sheft, Stanley and Yost, William A., Modulation detection interference with two-tone modulators, Journal of the Acoustical Society of America, 102, 1997

Yost, William A. Pitch Strength of Iterated Rippled Noise when the Pitch is Ambiguous, Journal of the Acoustical Society of America 101, 1644-1650, 1997

Sheft, Stanley and Yost, William A. Binaural modulation detection interference, Journal of the Acoustical Society of America, 102, 1997

1998

Yost, William A. Auditory Processing of Sounds with Temporal Regularity: Auditory Processing of Regular Interval Stimuli, Psychophysical and Physiological Advances in Hearing, Whurr Publishers, London, 1998

Yost, William A. Auditory Processing of Sounds with Temporal Regularity: Auditory Processing of Regular Interval Stimuli, Psychophysical and Physiological Advances in Hearing, Whurr Publishers, London, 1998

Yost, William A, Roy Patterson, and Stanley Sheft. The Role of the Envelope in Auditory Processing of Regular Interval Stimuli, Journal of the Acoustical Society of America 104, 2349-2361, 1998

Yost, William A, Roy Patterson, and Stanley Sheft. The Role of the Envelope in Auditory Processing of Regular Interval Stimuli, Journal of the Acoustical Society of America, in press

Interactions/Transitions:

Meeting Presentations:

1996

Guzman, S. and Yost, William A., Journal of the Acoustical Society of America 99, 2516, 1996.

Mapes-Riordan, D., Guzman, S. and Yost, William A., Journal of the Acoustical Society of America 99, 2516, 1996.

Sheft, Stanley and Yost, William A., AM Detection with one- and two-tone modulators, Journal of the Acoustical Society of America 99, 2540, 1996.

Stanley Sheft and William A. Yost, Discrimination of noise modulators, Journal of the Acoustical Society of America 100, 2594, 1996.

Sheft, Stanley and William A. Yost. The Perception of Modulation, Journal of the Acoustical Society of America 1997.

Shofner, W.P. and Yost, W.A. Discrimination of rippled-spectrum noise from flat-spectrum noise in chinchillas: Effects of noise bandwidth. Association for Research in Otolaryngology, St. Petersburg Beach, 1996

Yost, William A., Pitch Strength of Iterated Rippled Noise, Journal of the Acoustical Society of America 99, 2490, 1996.

Yost, William A., Pitch and pitch strength of iterated rippled noise: Is it the envelope or fine structure? Journal of the Acoustical Society of America 100, 2720, 1996.

Yost, William A. and R.D. Patterson. Timbre and pitch strength in iterated rippled noise, Journal of the Acoustical Society of America 100, 2750, 1996.

Yost, William A. Pitch Strength of Iterated Rippled Noise, Association for Research in Otolaryngology St. Petersburg Beach, 1996

Yost, William A. Pitch Strength of Iterated Rippled Noise, Association for Research in Otolaryngology St. Petersburg Beach, 1996

1997

Guzman, Sandra and Yost, W.A. Perceptual fusion of clicks: The precedence effect. Association for Research in Otolaryngology, St. Petersburg Beach, 1997

Guzman Sandra and William A. Yost, Magnitude estimation of perceptual fusion of multiple sound sources, Journal of the Acoustical Society of America 101, 306, 1997

Sheft, Stanley and William A. Yost. The Perception of Modulation, Journal of the Acoustical Society of America 1997.

Stanley Sheft, and William A. Yost, Detection and Discrimination of Amplitude Modulation, Journal of the Acoustical Society of America 101, 3060, 1997

Yost, William A. Defining the limits of pitch: Iterated rippled noise. Association for Research in Otolaryngology, St. Petersburg Beach, 1997

Yost, William A. and Dan Mapes-Riordan. Head Movements in Localization, Journal of the Acoustical Society of America 101, 3105, 1997

Yost, William A. and Shofner, William P. Regular Interval Stimuli: Are higher-order intervals necessary? Journal of the Acoustical Society of America 101, 1997

Yost, William A. Regular Interval Stimuli with More than One Pitch, Journal of the Acoustical Society of America 103, 2767, 1998

1998

Yost, William A and Sandra Guzman. The Precedence Effect: Echo Processing, Association for Research in Otolaryngology, St. Petersburg Beach, 1998

Yost, William A. The role of envelope in pitch processing: Psychoacoustics and Physiology, CCRMC, Standford University, 1998

Yost, William A. Regular Interval Stimuli with More than One Pitch, Journal of the Acoustical Society of America 103, 2767, 1998

Mapes-Riordan, Dan and Yost, William A. Temporal Properties of Loudness Recalibration, Journal of the Acoustical Society of America 103, 3020-3021, 1998

1999

Yost, William A. Temporal models of pitch processing, Journal of Acoustical Society of America 105, 939, 1999

Yost, William A. The Precedence Effect: Fusion and localization dominance, Journal of Acoustical Society of America 105, 1149, 1999

Mapes-Riordan, Dan and Yost, William A. Loudness recalibration and complex tones, Journal of

Acoustical Society of America 105, 1389, 1999

2000

Patterson, R.D., Yost W.A. Handel, S. and Datta, A.J. (2000) The perceptual tone/noise ratio of merged interated ripple noise, Journal of the Acoustical Society of America 107, 1578-1588

Inventions or patents: None

Honors: William A. Yost, Fellow, American Association for the Advancement of Science.
Doctor of Science, *honoris causa*, The Colorado College, 1997